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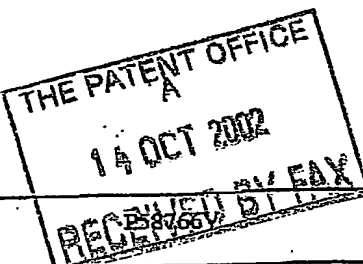
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The BOC Group plc
Chertsey Road
Windlesham
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GU20 6HJ

Patents ADP Number (if you know it)

884627002

If the applicant is a corporate body, give the country/state of its incorporation

UK

4. Title of the invention

PLUMP CLEANING

5. Name of your agent (if you have one)

Fry Heath & Spence LLP

"Address for service" in the United Kingdom
to which all correspondence should be sent
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The Gables
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I/We request the grant of a patent on the basis of this application.

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DUPLICATE

PUMP CLEANING

This invention relates to the field of vacuum pumps. In particular, but not strictly limited to vacuum pumps with a screw type configuration.

5 Screw pumps usually comprise two spaced parallel shafts each carrying externally threaded rotors, the shafts being mounted in a pump housing such that the threads of the rotors intermesh. Close tolerances between the rotor threads at the points of intermeshing and with the internal surface of the pump body, which typically acts as a stator, causes
10 volumes of gas being pumped between an inlet and an outlet to be trapped between the threads of the rotors and the internal surface and thereby urged through the pump as the rotors rotate.

Screw pumps are widely regarded as a reliable means for generating vacuum conditions in a multitude of processes. Consequently,
15 they are being applied to an increasing number of industrial processes. Such applications may involve materials that have "waxy" or "fatty" properties e.g. tallow based plasticisers. In operation of the pump, these products form deposits on the surfaces of the pump. On shutdown of the pump these surfaces cool, the deposits also cool and solidify within the
20 pump. Where such deposits are located in clearance regions between components, they can cause the pump to seize up such that restart is inhibited or even prevented. In order to release the rotors in prior art pumps, a facility is provided whereby a bar can be inserted into sockets attached to the primary shaft of the rotor through an access panel. This
25 bar is used as a lever to try to rotate the shaft and release the mechanism such that the machine can be restarted. This levering system allows more rotational force to be applied to the internal components than could be exerted by the motor. Such force will be transmitted to the rotor vanes and the associated stresses may prove to be detrimental to the structure
30 of the rotor. If this system fails to release the mechanism it is then necessary to disassemble the apparatus such that a liquid solvent can be poured into the pump casing to dissolve the residue to a level where the

shaft can be rotated manually. This disassembly not only causes the pump to be off line for a certain length of time, but it then must be re-commissioned and re-tested to ensure the reliability of the connections to the surrounding apparatus.

- 5 During operation, the waste products from the evacuated chamber pass from the inlet of the pump towards the outlet. Depending on what these waste products are, some materials can solidify as the pressure increases and others will react with the increase in temperature and form new particulate matter, in either case deposits form and collect on the
- 10 surfaces of the pump in normal operation. This build up of residue increases the friction forces that need to be overcome by the pump, as a consequence the motor must apply an increased level of torque which, in turn, reduces the speed of rotation which can be achieved. It follows that an increase in the level of residue is detrimental to the efficiency of the
- 16 apparatus.

It is an aim of the present invention to overcome the aforementioned problems associated with pump technology.

- According to the present invention there is provided a pump comprising at least one rotor, a stator and a housing enclosing the rotor,
- 20 the housing comprising at least one port, the at least one port extending through the housing to enable delivery of a fluid onto a surface of the at least one rotor.

- The housing may comprise an inner layer and an outer layer between which a cavity may be formed. In operation of the pump a liquid
- 25 may be passed through this cavity. The inner layer of the housing may act as the stator of the pump.

- The port(s) may be located downstream of the inlet portion of the rotor such that any fluid injected through the ports does not impinge on the primary flow within the pump which may be detrimental to the
- 30 performance of the pump. Where many ports are provided, these may be located in an array substantially in alignment with the centreline of the

pump. The port may include a nozzle through which, in use, fluid is sprayed, this nozzle may be integrally formed within the port.

5 A supply of fluid may be provided together with a means for conveying the fluid to the ports for delivery to the rotor. The fluid may be a liquid or a vapour. The fluid may be a solvent for dissolving residue collected on the rotor when the pump is in use or it may be steam

10 The pump may be a screw pump comprising two threaded rotors in which case the port(s) may be located after the first two complete turns of thread of the rotors from the inlet end of the rotor. Alternatively the pump may be a claw pump or a roots pump.

15 According to the present invention there is further provided a method for managing deposits within a pump mechanism, the method comprising the step of delivering fluid into the pump, the fluid suitable for dissolving, diluting or otherwise disengaging deposits which have accumulated on the internal working surfaces of the pump.

20 The delivery of fluid may occur at predetermined intervals during operation of the pump. Furthermore a monitoring step may be performed wherein the performance of the pump is monitored by measuring at least one of the group of rotor speed, power consumption, volumetric gas flow rate. These measured parameters may be used to determine the extent of accumulation of deposits on the internal working surfaces of the pump. A fluid flow rate may then be calculated, this rate being that of the delivered fluid that would be sufficient to compensate for the quantity of accumulated deposits as determined above. Subsequently, the flow rate
25 of fluid being delivered to the rotor may be adjusted to reflect the new calculated value.

30 According to the present invention there is further provided a method for managing deposits within a pump mechanism by introducing fluid suitable for dissolving, diluting or otherwise disengaging deposits which have accumulated on the internal working surfaces of the pump, the method comprising the steps of:

- (a) monitoring the performance of the pump by recording at least one of the group of rotor speed, power consumption, volumetric gas flow rate;
- 5 (b) calculating the rate of accumulation of deposits on the internal working surfaces of the pump, using at least one parameter from step (a);
- (c) calculating a fluid flow rate required to compensate for the accumulation of deposits as calculated in step (b); and
- 10 (d) effecting an adjustment of the flow rate of fluid being delivered to the rotor to reflect the calculated value from step (c).

The pump may be inoperative as the fluid is delivered, for example where seizure has occurred or where cleaning needs to take place. In this case, the method may further involve applying torque to the rotors of the pump in order to overcome any remaining impeding force potentially
15 caused by deposits located on the internal working components of the pump. Under certain conditions, for example where the material being transported is particularly viscous or waxy and this viscosity may reduce with an increase in temperature, the method may further involve the introduction of thermal fluid into a cavity provided within the housing of
20 the pump, where this cavity encircles the rotor components. This thermal fluid may be heated in order to raise the temperature of the fluid and the deposits sufficiently to release the deposits prior to applying the torque as discussed above.

The controller of the dry pump apparatus may comprise a
25 microprocessor which may be embodied in a computer, which in turn is optionally programmed by computer software which, when installed on the computer, causes it to perform the method steps (a) to (d) mentioned above. The carrier medium of this program may be selected from but is not strictly limited to a floppy disk, a CD, a mini-disc or digital tape.

30 An example of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates a schematic of a screw pump of the present invention;

Figure 2 illustrates a schematic of a double-ended screw pump of the present invention;

5 Figure 3 is an end sectional view of the pump of Figures 1 and 2; and

Figure 4 is a detailed view of a section of a water jacket that illustrates the implementation of an injection port.

Whilst the example pumps illustrated in Figures 1 and 2 are screw
10 pumps it is envisaged that this invention can be applied to any type of vacuum pump, in particular claw pumps. In the example of Figure 1, two rotors 1 are provided within an outer housing 5 that serves as the stator of the pump. The two contra-rotating, intermeshing rotors 1 are positioned such that their central axes lie parallel to one another. The
15 rotors are mounted through bearings 10 and driven by a motor 11. Injection ports 2 are provided along the length of the rotor, in the examples of Figures 1 and 2 (shown as solid lines in Figure 3) these ports 2 are located laterally within the pump on the opposite side of the rotors from the intermeshing region of the rotors. However, the ports may be
20 positioned at any radial location around the stator 5. Some of these locations are illustrated in Figure 3.

The ports 2, which may contain nozzles to allow the fluid to be sprayed, are preferably distributed along the length of the stator component 5 such that the solvent or steam can be easily applied over
25 the entire rotor. Alternatively, this distribution of ports allows the fluid to be readily concentrated in any particular problem area that may arise.

This is especially important when solvent is injected during operation, in order to limit the impact on pump performance. If, for example, a single port was to be used at the inlet 3 of the pump, this may have a
30 detrimental effect on the capacity of by-products that could be transported away from the evacuated chamber (not shown) by the pump. By bringing solvent into contact with the rotor 1 after the first few turns of

the thread, the likelihood of backward contamination of the solvent into the chamber will be reduced.

Furthermore, where solvent is introduced in the inlet region of the pump, the pressure is such at the inlet that there is an increased risk that the solvent will flash. In processes where it is necessary for the solvent to remain in liquid phase the solvent must be introduced closer towards the exhaust region of the pump where the pressures will have risen. As solvent is introduced through a number of ports 2 along the length of the stator, the overall effect is to gradually increase the quantity solvent present, as the likelihood of residue build up on the rotor 1 increases towards the exhaust stages. An additional benefit may be seen in some configurations where addition of liquid into the final turns of thread of the rotor will act to seal the clearances between the rotor and the stator in this region of the pump. Thus leakage of gas will be substantially reduced and performance of the pump will be improved.

In some processes, it is not appropriate to introduce solvent during operation as the waste products from the evacuated chamber are collected at the outlet of the pump for a particular purpose and this material ought not to be contaminated. Other applications may not result in levels of residue that warrant constant injection of solvent during operation. In these cases, and where an unplanned shut down of the pump occurs such that standard practices, such as purging, are not followed, the residue from the process cools down as the apparatus drops in temperature. In these circumstances a seizure of the mechanism may occur as deposits build up and become more viscous or solidify. In a system according to the present invention, the injection ports 2 can be used to introduce a solvent into the stator cavity 6 in a distributed manner without needing to go to the expense or inconvenience of disassembling the apparatus. Once the solvent has acted upon the deposits to either soften or dissolve them, the shaft may then be rotated either by using the motor or manually to release the components without applying excessive, potentially damaging, force to the rotor.

Delivery of fluid may be performed through simple ports as liquid is drip-fed through a hole in the housing or nozzles may be provided through which the fluid may be sprayed. Control systems may be introduced such that the solvent delivery can be performed in reaction to the changing
5 conditions being experienced within the confines of the pump apparatus.

Where the process material is waxy or fatty, compatible solvents will need to be introduced to perform the dilution/cleaning function. Such solvents may be provided in liquid or vapour form. Any compatible, effective cleaning medium may be used such as Xylene in the case of
10 hydrocarbon based/soluble products or water in the case of aqueous based / soluble, alternatively, detergents may be used.

The housing 5 as illustrated in Figure 3 is provided as a two-layer skin construction, an inner layer 6 and an outer layer 9. It is the inner layer 6 that acts as the stator of the pump. A cavity 7 is provided
15 between the layers 6, 9 of the housing 5 such that a cooling fluid, such as water, can be circulated around the stator in order to conduct heat away from the working section of the pump. This cavity 7 is provided over the entire length of the rotor i.e. over the inlet region 3 as well as the exhaust region 4. Under circumstances where the pump has become seized due to
20 cooling of the rotor which, in turn, solidifies residues on the surfaces between the rotor and the stator, the 'cooling liquid' in the cavity 7 of the housing 5 may be heated to raise the temperature of the rotor 1. This can enhance the pliability of the residue and may assist in releasing the mechanism. The housing 5 is provided with pillars 8 of solid material
25 through the cavity 7 in order to provide regions where injection ports 2 can be formed.

The present invention is not restricted for use in screw pumps and may readily be applied to other types of pump such as claw pumps or roots pumps.

30 It is to be understood that the foregoing represents just a few embodiments of the invention, others of which will no doubt occur to the

skilled addressee without departing from the true scope of the invention
as defined by the claims appended hereto.

Claims

1. A pump comprising:
at least one rotor;
a stator; and
5 a housing enclosing the rotor, the housing comprising at least one port, the at least one port extending through the housing to enable delivery of a fluid onto a surface of the at least one rotor.
2. A pump according to any claim 1, wherein the housing comprises a two skinned wall, a cavity being formed between an inner skin and an
10 outer skin of the wall, through which, in use, a liquid may be passed.
3. A pump according to claim 2, wherein the inner U of the housing acts as the stator, in use.
4. A pump according to any preceding claim, wherein the at least one port is located downstream of an inlet portion of the at least one rotor.
- 15 5. A pump according to any preceding claim, wherein a plurality of ports are provided, these ports being located in an array substantially in alignment with the centreline of the pump.
6. A pump according to any preceding claim, wherein at least one of the U ports includes a nozzle through which, in use, fluid is sprayed.
- 20 7. A pump according to claim 6, wherein the nozzle is integrally formed within the port.
8. A pump according to any of the preceding claims, further comprising:
a supply of fluid; and
a means for conveying the fluid to the ports for delivery to the at
25 least one rotor.
9. A pump according to claim 8, wherein the fluid is a liquid.
10. A pump according to claim 8 or claim 9, wherein the fluid is a solvent for dissolving residue collected on the rotor when the pump is in use.

11.A pump according to claim 8, wherein the fluid is steam.

12.A pump according to any preceding claim, wherein the pump is a screw pump comprising two threaded rotors.

13.A screw pump according to claim 12, wherein the at least one port is
5 located after the first two complete turns of thread of the rotors from the inlet end of the rotors.

14.A pump according to any of claims 1 to 11, wherein the pump is a claw pump.

15.A pump according to any of claims 1 to 11, wherein the pump is a
10 roots pump.

16.A method for managing deposits within a pump mechanism, the method comprising the step of:

15 delivering fluid into the pump, the fluid suitable for dissolving, diluting or otherwise disengaging deposits which have accumulated on the internal working surfaces of the pump.

17.A method according to claim 16, wherein the delivery step occurs at predetermined intervals during operation.

18.A method according to claim 16, further comprising the steps of:

20 (a) monitoring the performance of the pump by measuring at least one of the group of rotor speed, power consumption, volumetric gas flow rate;

(b) determining the accumulation of deposits on the internal working surfaces of the pump, using at least one parameter from step (a);

25 (c) calculating a fluid flow rate required to compensate for the accumulation of deposits as calculated in step (b); and

(d) adjusting the flow rate of fluid being delivered to the rotor to reflect the calculated value from step (c).

19.A method for managing deposits within a pump mechanism by introducing fluid suitable for dissolving, diluting or otherwise disengaging deposits which have accumulated on the internal working surfaces of the pump, the method comprising the steps of:

- 5 (a) monitoring the performance of the pump by recording at least one of the group of rotor speed, power consumption, volumetric gas flow rate;
- (b) calculating the rate of accumulation of deposits on the internal working surfaces of the pump, using at least one parameter from
- 10 step (a);
- (c) calculating a fluid flow rate required to compensate for the accumulation of deposits as calculated in step (b); and
- (d) effecting an adjustment of the flow rate of fluid being delivered to the rotor to reflect the calculated value from step (c).

- 15 20.A method according to claim 16, wherein the pump is inoperative as the fluid is delivered, the method further comprising the step of:
- applying torque to the rotors of the pump to overcome any remaining impeding force.

- 21.A method according to claim 20, further comprising the steps of:
- 20 introducing a thermal fluid into a cavity provided within the housing of the pump, the cavity encircling the rotor components; and heating the thermal fluid in the cavity to raise the temperature of the fluid and the deposits sufficiently to release the deposits prior to the torque applying step.

- 25 22.A computer program which, when installed on a computer, causes the computer to perform the method of claim 19.

23.A computer readable carrier medium which carries a computer program as claimed in claim 22.

- 24.A computer readable carrier medium according to claim 23, wherein
- 30 the medium is selected from; a floppy disk, a CD, a mini-disc or digital tape.

25.A pump apparatus substantially as described herein with reference to the Figures 1 to 4.

ABSTRACT**PUMP CLEANING**

A pump comprises at least one rotor 1, a stator 5 and a housing 5, the rotor 1 being enclosed by the housing 5. The housing 5 comprises at least one port 2 extending through the housing 5 to enable delivery of a fluid directly onto a surface of the at least one rotor 1.

(Fig. 1)

10

1/2

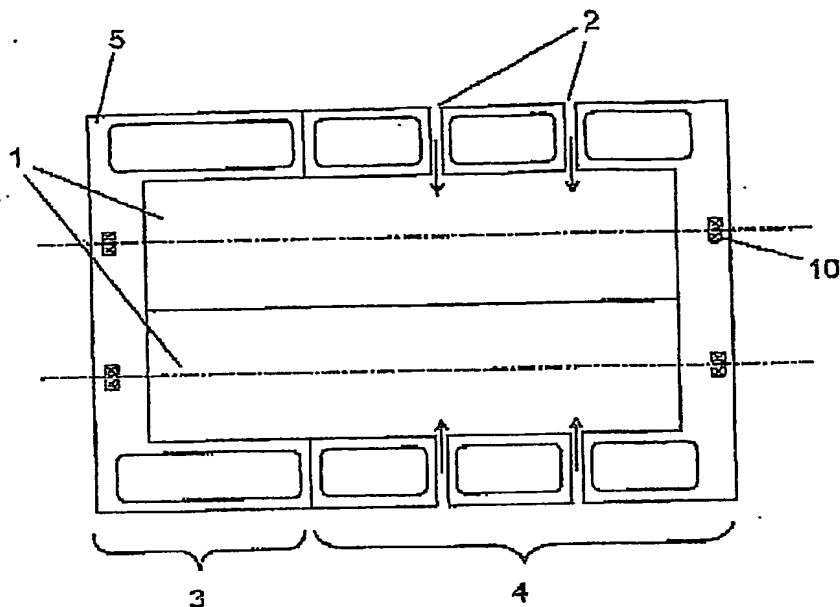


Figure 1

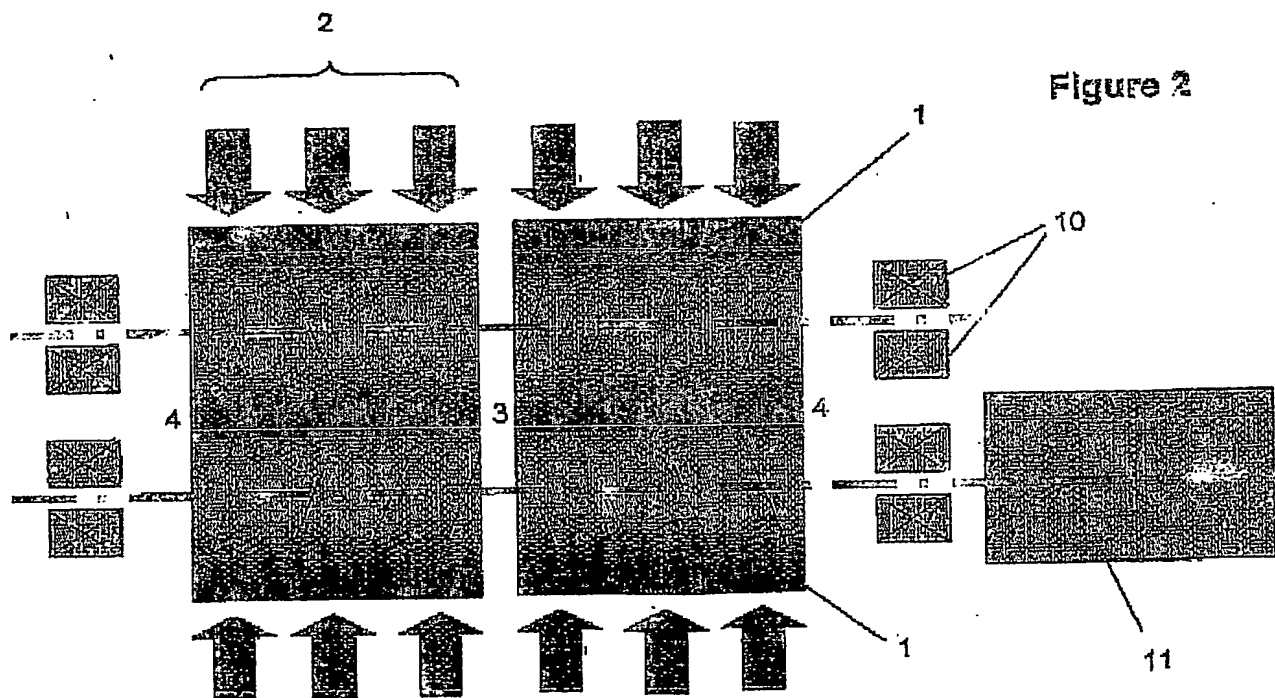


Figure 2

2/2

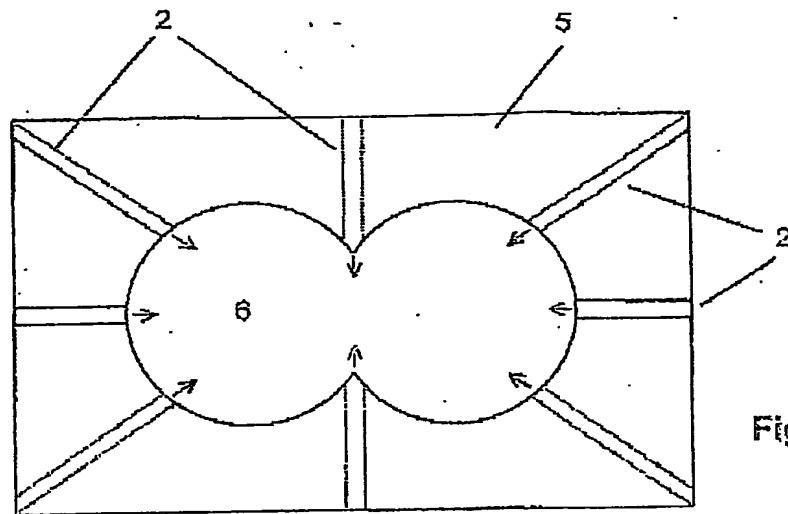


Figure 3

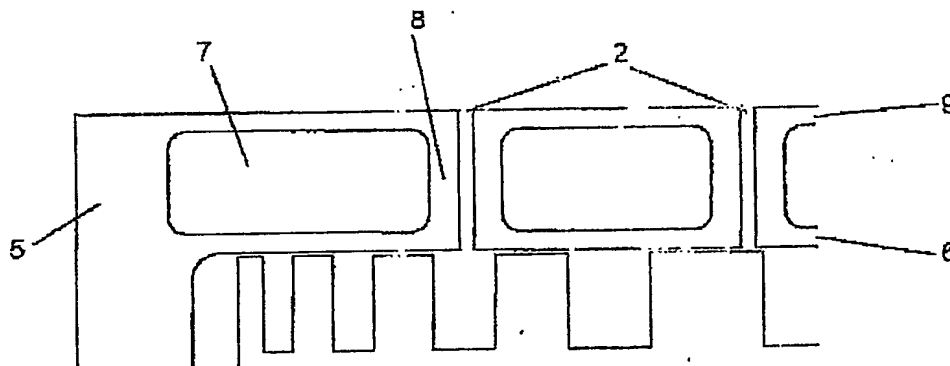


Figure 4

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